

Relative Velocity and Riverboat Problems

Read from **Lesson 1** of the **Vectors and Motion in Two-Dimensions** chapter at **The Physics Classroom**:

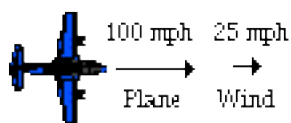
<http://www.physicsclassroom.com/Class/vectors/u3l1f.html>

<http://www.physicsclassroom.com/Class/vectors/u3l1g.html>

MOP Connection: Vectors and Projectiles: sublevel 6 (and maybe sublevel 5)

- Planes fly in a medium of moving air (winds), providing an example of relative motion. If the speedometer reads 100 mi/hr, then the plane moves 100 mi/hr relative to the air. But since the air is moving, the plane's speed relative to the ground will be different than 100 mi/hr. Suppose a plane with a 100 mi/hr air speed encounters a tail wind, a head wind and a side wind. Determine the resulting velocity (magnitude and CCW direction) of the plane for each situation.

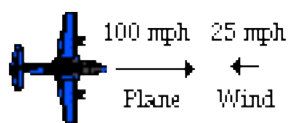
Tail Wind



Magnitude:

CCW Direction:

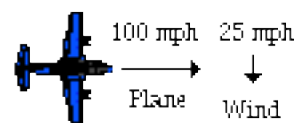
Head Wind



Magnitude:

CCW Direction:

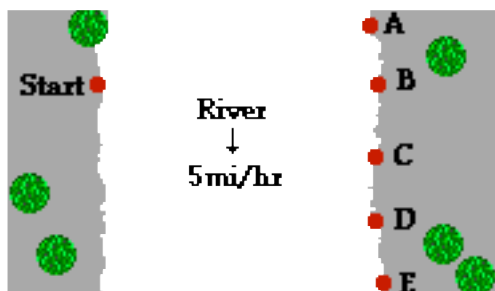
Side Wind



Magnitude:

CCW Direction:

- The situation of a plane moving in the medium of moving air is similar to a motorboat moving in the medium of moving water. In a river, a boat moves relative to the water and the water moves relative to the shore. The result is that the resultant velocity of the boat is different than the boat's speedometer reading, *thanks to* the movement of the water that the boat is in. In the diagram below, a top view of a river is shown. A boat starts on the west side (left side) of the river and heads a variety of directions to get to the other side. The river flows south (down). Match the boat headings and boat speeds to the indicated destinations. Use each letter once.



Boat Heading	Boat Speed	Destination (A, B, C, D or E)
→	14 mi/hr	
→	7 mi/hr	
↗	7 mi/hr	
→	20 mi/hr	
↗	12 mi/hr	

- A pilot wishes to fly due North from the Benthree Airport to the Donthat Airport. The wind is blowing *out of the Southwest* at 30 mi/hr. The small plane averages a velocity of 180 mi/hr. What heading should the pilot take? Use a sketch to help solve.



Vectors and Projectiles

4. A riverboat heads east on a river that flows north. The riverboat is moving at 5.1 m/s with respect to the water. The water moves north with respect to the shore at a speed of 3.6 m/s .
 - a. Determine the resultant velocity of the riverboat (velocity with respect to the shore).
 - b. If the river is 71.0 m wide, then determine the time required for the boat to cross the river.
 - c. Determine the distance that the boat will travel downstream.
5. Suppose that the boat attempts this same task of crossing the river (5.1 m/s with respect to the water) on a day in which the river current is greater, moving at 4.7 m/s with respect to the shore. Determine the same three quantities - (a) resultant velocity, (b) time to cross the river, and (c) distance downstream.
6. For a boat *heading* straight across a river, does the speed at which the river flows effect the time required for the boat to cross the river? _____ Explain your answer.
7. Repeat the same three riverboat calculations for the following two sets of given quantities.

Velocity of boat (w.r.t. water) = 3.2 m/s , East Velocity of river (w.r.t. shore) = 4.4 m/s , South Width of river = 127 m	Velocity of boat (w.r.t. water) = 2.6 m/s , West Velocity of river (w.r.t. shore) = 4.2 m/s , South Width of river = 96 m
a. Resultant velocity: magnitude = _____ direction = _____	a. Resultant velocity: magnitude = _____ direction = _____
b. Time to cross river = _____	b. Time to cross river = _____
c. Distance downstream = _____	c. Distance downstream = _____